AK

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/021,683	11/28/2001	Russell A. Wincheski	LAR 16116-1	9204

23351 7590 10/10/2003

NATIONAL AERONAUTICS AND SPACE ADMINISTR
ATION LANGLEY RESEARCH CENTER
3 LANGLEY BOULEVARD
MAIL STOP 212
HAMPTON, VA 236812199

EXAMINER	
KINDER, DARRELL D	
ART UNIT	**PAPER NUMBER**
2862	

DATE MAILED: 10/10/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/021,683	WINCHESKI ET AL.
	Examin r	Art Unit
	Darrell Kinder	2862

-- The MAILING DATE of this communication appears on the cover she t with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 August 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-37* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-37* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 6.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under U.S.C. 103(a).

The following rejection has been maintained from paper no. 5 for the reasons indicated in section 60 below. An additional, new, rejection is introduced in section 33 below.

1. Claims 1-13, 15-23, 26-33, and 35-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent no. 5,648,721 (Wincheski) in view of Wincheski et al. "Deep Flaw Detection With Giant Magnetoresistive (GMR) Based Self-Nulling Probe," *26th Annual Review of Progress in QNDE*, Montreal, Canada, July 1999 ('99 Review).

Regarding claims 1, 20, and 26, Wincheski discloses an eddy current device for non-destructive evaluation of an electrically conductive material, comprising: an excitation coil (**Fig. 1** 11) for inducing eddy currents within the electrically conductive material (16), the excitation coil having windings wherein the excitation coil's longitudinal axis is perpendicular to the surface of the electrically conductive material; a magnetic sensor (13) having a longitudinal axis perpendicular to the surface of the electrically conductive sample (16) and surrounded by the windings of the excitation coil (11); a tubular flux focusing lens (12) disposed between the excitation coil and the sensor, composed of a conductive material having a high magnetic permeability, having a closed end opening opposite the surface of the electrically conductive material and having an opening adjacent to the surface of the electrically conductive material and which prevents magnetic coupling between the excitation coil and the sensor and which produces high flux density at the outer edge of the sensor (col. 10 lines 47-58).

Regarding claim 20, Wincheski further discloses a flux-focusing shield (**Fig. 7** 70) which surrounds the excitation coil (col. 7 lines 44-51).

Regarding claim 26, Wincheski further discloses rotator means (**Fig. 17** 110) for rotating the device about the circular inhomogeneity such that the center of the device remains a constant distance from the center of the circular inhomogeneity (col. 9 lines 38-48; col. 10 lines 59-62).

Wincheski discloses a pickup coil as the sensor (col. 5 lines 65-67), and hence does not disclose the use of a giant magnetoresistive sensor. The tubular flux-focusing lens of Wincheski has one closed end, instead of two openings. Furthermore, Wincheski does not disclose the use of a feedback coil.

Wincheski, in the '99 Review discloses a flux focusing giant magnetoresistive sensor for nondestructive evaluation wherein the sensor comprises a GMR sensor instead of a pickup coil, and the use of two open ends of a tubular flux focusing device. The '99 Review teaches the benefits of using a giant magnetoresistive sensor to sense magnetic fields as they offer have a small package size, consume little power and operate at room temperature (paragraph 1). The '99 Review further teaches the use of a feedback coil positioned adjacent to the giant magnetoresistive sensor along the longitudinal axis thereof and surrounded by the windings of the excitation coil and the flux focusing lens (**Fig. 3**) as it enables a complete cancellation of any sinusoidal stray fields at the GMR sensor location, and for shifting the operating point of the GMR sensor out of the low field region where the sensitivity of the device is low (paragraph 9). This prior art first teaches that a GMR sensor is an improvement, and then further

teaches that the use of a feedback coil alleviates problems of the GMR, providing an even further benefit.

One of ordinary skill in the art would have been motivated the probe of Wincheski with the teachings of the '99 review and replace the pickup coil as the sensor with the GMR sensor, as it is a more efficient and accurate sensor. Furthermore, to take full advantage of the improved magnetic sensor, the GMR sensor, one of ordinary skill in the art would have incorporated a feedback coil to completely cancel any sinusoidal stray fields and for shifting the operating point of the GMR sensor out of the low sensitivity region.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Wincheski with the teachings presented at the '99 Review such that the pickup coil of Wincheski is replaced with a GMR sensor to enhance efficiency and performance, and further enhanced in combination with the addition of the feedback coil and second open end of a flux focusing lens, as it would greatly improve the ability to perform nondestructive evaluation on electrically conductive materials.

The following rejections assume the use of the giant magnetoresistive sensor in combination with the feedback coil as a replacement for the pickup coil of Wincheski, as detailed above. Furthermore, the combination incorporates the entire teachings of both references.

2. Referring to claim 2, Wincheski discloses an eddy current device wherein the windings of the excitation coil are substantially circular (col. 6 lines 4-9).

3. Regarding claim 3, the '99 Review discloses the eddy current device wherein the excitation coil is substantially concentrically disposed around the giant magnetoresistive sensor and the feedback coil (**Fig. 3**).

4. Referring to claim 4, Wincheski discloses a device additionally comprising means for applying a drive current (**Fig. 1** 15) to the windings of the excitation coil, wherein the frequency is dependent on the desired depth of flaw detection (col. 6 lines 40-46).

5. Referring to claim 5, the '99 Review discloses a device additionally comprising means for applying a feedback current to the windings of the feedback coil. The feedback current having the same frequency as the drive current but 180 degrees out of phase with the giant magnetoresistive signal (paragraph 11)

6. Referring to claim 6, the '99 review discloses an eddy current device additionally comprising biasing means for biasing the giant magnetoresistive sensor (paragraph 11).

7. Referring to claim 7, the '99 Review further discloses that the biasing means is a D.C. voltage applied to the feedback coil (paragraph 11).

8. Regarding claim 8, although neither Wincheski nor the '99 Review disclose that the biasing means is a permanent magnet. However, it is well known that a permanent magnet is often the simplest biasing means of a giant magnetoresistive device, and one of ordinary skill in the art would have been able to modify the proposed combination of Wincheski and the '99 Review such that the biasing means is a permanent magnet, as it is well known and may offer advantages, such as being less expensive, and less power consuming than using a biasing current.

9. Referring to claim 9, Wincheski discloses that the flux-focusing lens is composed of a conducting material of high magnetic permeability (col. 10 lines 47-48).

10. Referring to claim 10, Wincheski discloses the eddy current device further comprising an amplifying means (**Fig. 8A** 72) for amplifying the output of the sensor; and a detection means (14) for registering the output of the amplifying means.

11. Regarding to claims 11 and 28, Wincheski discloses that the amplifying means is a differential preamplifier (col. 7 line 65).

12. In reference of claim 12, Wincheski discloses that the detection means is an A.C. Voltmeter (col. 7 line 67).

13. Referring to claim 13, the '99 Review discloses that the giant magnetoresistive sensor is a packaged eight pin integrated chip (paragraph 6).

14. Referring to claim 15, Wincheski discloses the eddy current device wherein the thickness of the flux focusing lens is at least three skin depths of a magnetic flux generated by the drive current applied to the excitation coil (col. 6 lines 16-31).

15. Referring to claim 16, Wincheski and the '99 Review discloses a device wherein the flux focusing lens is substantially cylindrical and the excitation coil is concentrically disposed around the flux focusing lens (Wincheski: **Fig. 2**, col. 6 lines 4-9; '99 Review: **Fig. 3**).

16. Referring to claims 17-18, Wincheski discloses that the pickup coil is less than one half the height of the excitation coil (col. 10 lines 44-46). Wincheski chooses such a height, as the maximum penetration of the concentrated magnetic field within the lens is equal to one half the excitation coil height.

It follows that since the flux-focusing lens is equal to or greater than the height of the excitation coil (**Figs. 2, 17**) the pickup coil would also be less than half the height of the flux-focusing lens.

Furthermore, if one of ordinary skill in the art replaced the pickup coil with the superior GMR sensor as taught in the '99 Review, it would be obvious to one of ordinary skill in the art to have the giant magnetoresistive sensor also be half the height of the excitation coil, and hence the flux focusing lens, as it is a dimension that allows the maximum sensitivity of the sensor in picking up the changes in the concentrated magnetic field.

17. Referring to claim 19, the '99 Review discloses an eddy current device wherein the bottom of the edge of the giant magnetoresistive sensor is co-planar with the bottom edge of the excitation coil and the second opening of the flux focusing lens (**Fig. 3**).

18. Regarding claim 21, Wincheski discloses a device wherein the flux-focusing shield is composed of a conducting material of high permeability (col. 7 lines 44-45).

19. Regarding claim 22, Wincheski discloses an eddy current device highly resistant to lift off conditions for nondestructive evaluation of electrically conductive material comprising a plurality of flux focusing eddy current probes and additionally comprising a casing (**Fig. 8A**; col. 7 lines 54-60).

Wincheski does not disclose that the probes are giant magnetoresistive probes.

The '99 Review teaches that the use of GMR sensors in NDE evaluation has provided many benefits and widened the field (paragraphs 1-2).

One of ordinary skill in the art would have looked to the teachings of the '99 Review to modify Wincheski as they are both in NDE, and by incorporating the teachings contained in the '99 review, one of ordinary skill in the art could gain some of the benefits associated with the use of GMR sensors and probes which use GMR sensors.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Wincheski such that the plurality of probes within a casing were GMR probes, as taught in the '99 Review, as it would provide a more efficient and accurate sensor.

20. Referring to claim 23, Wincheski discloses an excitation coil (**Fig. 1** 11) for inducing eddy currents within the electrically conductive material (16), the excitation coil having windings wherein the excitation coil's longitudinal axis is perpendicular to the surface of the electrically conductive material; a plurality of magnetic sensor (**Fig. 8B** 73A, 73B) each surrounded by the windings of the excitation coil (11); a flux focusing lens (12) disposed between the excitation coil and the sensor, composed of a conductive material having a high magnetic permeability, having a closed end opening opposite the surface of the electrically conductive material and having an opening adjacent to the surface of the electrically conductive material and which prevents magnetic coupling between the excitation coil and the sensor and which produces high flux density at the outer edge of the sensor (col. 10 lines 47-58).

Wincheski discloses a pickup coil as the sensor (col. 5 lines 65-67), and hence does not disclose the use of a giant magnetoresistive sensor. The tubular flux-focusing lens of

Wincheski has one closed end, instead of two openings. Furthermore, Wincheski does not disclose the use of a feedback coil.

As above, Wincheski, in the '99 Review discloses a flux focusing giant magnetoresistive sensor for nondestructive evaluation wherein the sensor comprises a GMR sensor instead of a pickup coil, and the use of two open ends of a tubular flux focusing device. The '99 Review teaches the benefits of using a giant magnetoresistive sensor to sense magnetic fields as they offer have a small package size, consume little power and operate at room temperature (paragraph 1). The '99 Review further teaches the use of a feedback coil positioned adjacent to the giant magnetoresistive sensor along the longitudinal axis thereof and surrounded by the windings of the excitation coil and the flux focusing lens **(Fig. 3)** as it enables a complete cancellation of any sinusoidal stray fields at the GMR sensor location, and for shifting the operating point of the GMR sensor out of the low field region where the sensitivity of the device is low (paragraph 9). This prior art first teaches that a GMR sensor is an improvement, and then further teaches that the use of a feedback coil alleviates problems of the GMR, providing an even further benefit.

One of ordinary skill in the art would have been motivated to modify the probe of Wincheski with the teachings of the '99 review and replace the pickup coils as the sensors with GMR sensors, as it is a more efficient and accurate sensor. Furthermore, to take full advantage of the improved magnetic sensor, the GMR sensors, one of ordinary skill in the art would have incorporated feedback coils to completely cancel any sinusoidal stray fields and for shifting the operating point of the GMR sensors out of the

low sensitivity region. The argument for the replacement of one pickup coil for one GMR sensor and feedback coil pair can be extended to a plurality of magnetic sensors or pickup coils.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the embodiment with a plurality of magnetic sensors of Wincheski with the teachings presented at the '99 Review such that the pickup coils of Wincheski are replaced with GMR sensors to enhance efficiency and performance, and further enhanced in combination with the addition of feedback coils and second open end of a flux focusing lens, as it would greatly improve the ability to perform nondestructive evaluation on electrically conductive materials.

21. Referring to claim 27, Wincheski discloses the eddy current device further comprising an amplifying means (**Fig. 8A** 72) for amplifying the output of the sensor; and a detection means (14) for registering the output of the amplifying means, monitoring means (**Fig. 9** 82) for monitoring the output of the sensor; and scanning means (85-86; col. 8 lines 1-15) for scanning the device about the circumference of the circular inhomogeneity.

22. Regarding claim 29, although neither Wincheski or the teachings of the '99 Review specifically disclose the use of a peak to peak detector, the use of such an instrument or even a peak detector, is not novel, and is well known in the art of NDE. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the proposed combination such that the detection

means is a peak to peak to detector as it is a well known means for detecting the peaks of the acquired signal.

23. Referring to claim 30, Wincheski discloses a device wherein the monitoring means is a computer (col. 8 line 9).

24. Regarding claim 31, Wincheski discloses a device wherein the scanning means is a stepper motor (col. 8 lines 11-12).

25. Referring to claim 32 the '99 Review discloses the device wherein the detection means comprises amplified low pass filtering of an amplitude modulated notch-filtered giant magnetoresistive signal (paragraphs 16-17).

26. Referring to claim 33, Wincheski discloses means for applying a drive current to the windings of the excitation coil (**Fig. 1** 15), wherein the frequency is dependent on the desired depth of flaw detection (col. 6 lines 40-46). The '99 review discloses means for applying a feedback current to the windings of the feedback coil, the feedback current having the same frequency as the drive current but 180 degrees out of phase with the giant magnetoresistive signal (paragraph 11).

27. Regarding claim 35, the '99 review discloses the device further comprising spatial Fourier filtering of the amplified low-pass filtered signal (paragraph 17).

28. In reference of claim 36, which describes a method for processing the data in an array, the combination does not disclose the use of an array for data processing. However, in this day and age of computers, the use of arrays for manipulating data is well known, and has been established in the art of NDE. Furthermore, one specific array

manipulation is not any different or improved upon another one, and they often are tailored in order to meet the needs of the particular function that they are designed for.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the combination of Wincheski and the '99 Review to incorporate a data array manipulation in order to obtain the desired NDE information, as the computer of Wincheski could easily be adapted to perform and process a variety of array manipulations, and any particular manipulation to obtain the desired NDE information could be obtained without undue experimentation.

29. Claims 14 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wincheski-'99 Review as applied to claims 1 and 33 above, and further in view of U.S. Patent no. 6,504,363 (Dogaru).

Referring to claim 14, the '99 Review, which describes the GMR sensor to be used in the combination with Wincheski, does not disclose that the sensor is in its die form.

However, the die form is a well-known form of giant magnetoresistive sensors, and it is often through further modification that a GMR sensor in its die from becomes a GMR sensor in an eight-pin chip. Furthermore, Dogaru discloses a method and apparatus for detecting defects in materials comprising a giant magnetoresistive sensor, wherein it is further taught that the giant magnetoresistive sensor can be in die form (col. 8 lines 1-9).

One of ordinary skill in the art would have been motivated to use Dogaru to modify the proposed combination of Wincheski with the '99 Review, as it is analogous

art, being concerned with NDE using a GMR sensor. Furthermore one of ordinary skill in the art would have modified the combination to use a GMR sensor in die form, a sit is a simpler construction of the sensor.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the combination of Wincheski and the teachings of the '99 Review with the further teachings of Dogaru such that the GMR sensor was in die form as it is a simpler construction, and may decrease production costs.

30. Referring to claim 34, although the proposed combination does not explicitly disclose the use of a computer to control the amplitude, frequency and phase angle of the source signals, Wincheski and the '99 Review both allude to the use of a computer.

Dogaru further discloses the use of a computer to control the scanning of a specimen (col. 8 lines 60-67; col. 9 lines 1-31). The computer is a useful tool as it allows specific software to be written for performing the desired scan.

One of ordinary skill in the art would have been motivated to modify the combination by initiating computer control of the test parameters, as it would allow a higher degree of accuracy, as well as automation.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the proposed combination with the teachings of Tiernan such that the computer of Wincheski is further adapted to be used for controlling the various parameters of the test as it would allow for a higher degree of

accuracy and allow automation of the test, resulting in more accurate and more expedient NDE.

31. Claims 24-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wincheski- '99 Review as applied to claim 1 above, and further in view of U.S. Patent no. 6,150,809 (Tiernan).

Regarding claim 24, neither the Wincheski patent nor the teachings of the '99 Review specifically disclose processing means. However one of ordinary skill in the art would recognize that processing means are well known and useful as they allow for further processing of the signals to obtain the necessary information concerning location and size of defects when doing NDE.

Tiernan discloses a method and device for performing nondestructive evaluation of conductive materials comprising a giant magnetoresistive sensor wherein the device further comprises processing means for processing the signal (col. 5 lines 54-59col. 11 lines 23-25; col. 13 lines 60-62).

One of ordinary skill in the art would have looked to the teachings of Tiernan to modify the proposed combination of Wincheski and the '99 Review as it is analogous art, being concerned with NDE using a giant magnetoresistive sensor. Furthermore one of ordinary skill in the art would have been motivated to modify the combination to further include a processor, as it would allow the user to process the raw signals taken from the GMR sensor and discern useful, viable NDE information from them.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the combination of Wincheski and the

teachings of the '99 Review further with the teachings of Tiernan to include a processor to make the combination a more useful, and accurate NDE device.

32. Referring to claim 25, the '99 Review discloses processing means wherein the processing comprises data analysis obtaining a phase rotated amplitude, flattening the phase rotated amplitude and applying a low pass two-dimensional Fourier filter (paragraph 17).

33. Claims 1-4, 6-12, 15-24, 26-31, 33, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wincheski in view of Tiernan.

Regarding claims 1, 20, and 26, Wincheski discloses an eddy current device for non-destructive evaluation of an electrically conductive material, comprising: an excitation coil (**Fig. 1** 11) for inducing eddy currents within the electrically conductive material (16), the excitation coil having windings wherein the excitation coil's longitudinal axis is perpendicular to the surface of the electrically conductive material; a magnetic sensor (13) having a longitudinal axis perpendicular to the surface of the electrically conductive sample (16) and surrounded by the windings of the excitation coil (11); a tubular flux focusing lens (12) disposed between the excitation coil and the sensor, composed of a conductive material having a high magnetic permeability, having a closed end opening opposite the surface of the electrically conductive material and having an opening adjacent to the surface of the electrically conductive material and which prevents magnetic coupling between the excitation coil and the sensor and which produces high flux density at the outer edge of the sensor (col. 10 lines 47-58).

Additionally, with respect to the additions of claim 20, Wincheski further discloses a flux-focusing shield (**Fig. 7** 70) which surrounds the excitation coil (col. 7 lines 44-51).

Additionally, with respect to the additions of claim 26, Wincheski further discloses rotator means (**Fig. 17** 110) for rotating the device about the circular inhomogeneity such that the center of the device remains a constant distance from the center of the circular inhomogeneity (col. 9 lines 38-48; col. 10 lines 59-62).

Wincheski discloses a pickup coil as the sensor (col. 5 lines 65-67), and hence does not disclose the use of a giant magnetoresistive sensor. The tubular flux-focusing lens of Wincheski has one closed end, instead of two openings. Furthermore, Wincheski does not disclose the use of a feedback coil.

Tiernan discloses an apparatus for nondestructive evaluation wherein a GMR sensor is used to detect eddy currents generated within a material under test to determine flaws (col. 10 lines 22-37). Tiernan further discloses the use of a feedback coil (col. 9 lines 57-59) and a tubular cavity that is open on both ends (**Fig. 1b**). Tiernan teaches that the use of a GMR sensor is an improvement over coil-based eddy current sensors as it offers improved signal to noise ratio, high spatial resolution, and superior depth profiling (col. 9 lines 7-11). Furthermore, Tiernan teaches that a feedback filter is used to protect the GMR sensor from large applied fields (col. 9 lines 57-59). Tiernan also demonstrates that a tubular flux focusing arrangement can have two openings (**Fig. 1b**; col. 15 lines 24-30), which could be utilized to obtain a specific flux concentration.

One of ordinary skill in the art would have been motivated to modify the apparatus of Wincheski with the teachings of Tiernan such that a GMR sensor was

used instead of a coil, with a feedback filter, and further modified such that the tubular flux focusing lens had an opening at two sides in order to produce a combination apparatus which has a better signal to noise ratio, higher spatial resolution, protection against large fields, and a desired flux concentration which is able to better evaluate materials.

The following rejections assume the use of the giant magnetoresistive sensor in combination with the feedback coil as a replacement for the pickup coil of Wincheski, as detailed above. Furthermore, the combination incorporates the entire teachings of both references.

34. Referring to claim 2, Wincheski discloses an eddy current device wherein the windings of the excitation coil are substantially circular (col. 6 lines 4-9).

35. Regarding claim 3, Tiernan discloses the eddy current device wherein the excitation coil (**Fig. 1b** 40) is substantially concentrically disposed around the giant magnetoresistive sensor (50) and the feedback coil (col. 9 lines 57-59).

36. Referring to claim 4, Wincheski discloses a device additionally comprising means for applying a drive current (**Fig. 1** 15) to the windings of the excitation coil, wherein the frequency is dependent on the desired depth of flaw detection (col. 6 lines 40-46).

37. Referring to claim 6, Tiernan discloses an eddy current device additionally comprising biasing means for biasing the giant magnetoresistive sensor (col. 15 lines 10-11).

38. Referring to claim 7, Tiernan further discloses that the biasing means is a D.C. voltage applied to the feedback coil (col. 15 lines 10-11).

39. Regarding claim 8, although neither Wincheski nor Tiernan disclose that the biasing means is a permanent magnet. However, it is well known that a permanent magnet is often the simplest biasing means of a giant magnetoresistive device, and one of ordinary skill in the art would have been able to modify the proposed combination of Wincheski and Tiernan such that the biasing means is a permanent magnet, as it is well known and may offer advantages, such as being less expensive, and less power consuming than using a biasing current.

40. Referring to claim 9, Wincheski discloses that the flux-focusing lens is composed of a conducting material of high magnetic permeability (col. 10 lines 47-48).

41. Referring to claim 10, Wincheski discloses the eddy current device further comprising an amplifying means (**Fig. 8A** 72) for amplifying the output of the sensor; and a detection means (14) for registering the output of the amplifying means.

42. Regarding to claims 11 and 28, Wincheski discloses that the amplifying means is a differential preamplifier (col. 7 line 65).

43. In reference of claim 12, Wincheski discloses that the detection means is an A.C. Voltmeter (col. 7 line 67).

44. Referring to claim 15, Wincheski discloses the eddy current device wherein the thickness of the flux focusing lens is at least three skin depths of a magnetic flux generated by the drive current applied to the excitation coil (col. 6 lines 16-31).

45. Referring to claim 16, Wincheski discloses a device wherein the flux-focusing lens is substantially cylindrical and the excitation coil is concentrically disposed around the flux-focusing lens (Wincheski: **Fig. 2**, col. 6 lines 4-9).

46. Referring to claims 17-18, Wincheski discloses that the pickup coil is less than one half the height of the excitation coil (col. 10 lines 44-46). Wincheski chooses such a height, as the maximum penetration of the concentrated magnetic field within the lens is equal to one half the excitation coil height.

It follows that since the flux-focusing lens is equal to or greater than the height of the excitation coil (**Figs. 2, 17**) the pickup coil would also be less than half the height of the flux-focusing lens.

Furthermore, if one of ordinary skill in the art replaced the pickup coil with the superior GMR sensor as taught by Tiernan, it would be obvious to one of ordinary skill in the art to have the giant magnetoresistive sensor also be half the height of the excitation coil, and hence the flux focusing lens, as it is a dimension that allows the maximum sensitivity of the sensor in picking up the changes in the concentrated magnetic field.

47. Referring to claim 19, Tiernan discloses an eddy current device wherein the bottom of the edge of the giant magnetoresistive sensor is co-planar with the bottom edge of the excitation coil and the second opening of the flux-focusing lens (**Fig. 7a** 50).

48. Regarding claim 21, Wincheski discloses a device wherein the flux-focusing shield is composed of a conducting material of high permeability (col. 7 lines 44-45).

49. Regarding claim 22, Wincheski discloses an eddy current device highly resistant to lift off conditions for nondestructive evaluation of electrically conductive material comprising a plurality of flux focusing eddy current probes and additionally comprising a casing (**Fig. 8A**; col. 7 lines 54-60).

Wincheski does not disclose that the probes are giant magnetoresistive probes.

Tiernan teaches that the use of GMR sensors in NDE evaluation is superior to existing eddy current technology due to its excellent signal to noise ratio, high spatial resolution and depth profiling (col. 9 lines 8-11).

One of ordinary skill in the art would have looked to the teachings of Tiernan to modify Wincheski as they are both in NDE, and by incorporating the teachings contained in Tiernan, one of ordinary skill in the art could gain some of the benefits associated with the use of GMR sensors and probes which use GMR sensors.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Wincheski such that the plurality of probes within a casing were GMR probes, as taught by Tiernan, as it would provide a more efficient and accurate sensor.

50. Referring to claim 23, Wincheski discloses an excitation coil (**Fig. 1** 11) for inducing eddy currents within the electrically conductive material (16), the excitation coil having windings wherein the excitation coil's longitudinal axis is perpendicular to the surface of the electrically conductive material; a plurality of magnetic sensor (**Fig. 8B** 73A, 73B) each surrounded by the windings of the excitation coil (11); a flux focusing lens (12) disposed between the excitation coil and the sensor, composed of a conductive material having a high magnetic permeability, having a closed end opening opposite the surface of the electrically conductive material and having an opening adjacent to the surface of the electrically conductive material and which prevents

magnetic coupling between the excitation coil and the sensor and which produces high flux density at the outer edge of the sensor (col. 10 lines 47-58).

Wincheski discloses a pickup coil as the sensor (col. 5 lines 65-67), and hence does not disclose the use of a giant magnetoresistive sensor. The tubular flux-focusing lens of Wincheski has one closed end, instead of two openings. Furthermore, Wincheski does not disclose the use of a feedback coil.

As above, Tiernan discloses a giant magnetoresistive sensor for nondestructive evaluation wherein the sensor comprises a GMR sensor instead of a pickup coil, and the use of two open ends of a tubular flux-focusing device. Tiernan teaches the benefits of using a giant magnetoresistive sensor to sense magnetic fields as they provide excellent signal to noise ratio, high spatial resolution and depth profiling (col. 9 lines 8-11). Tiernan further teaches the use of a feedback coil positioned adjacent to the giant magnetoresistive sensor along the longitudinal axis thereof and surrounded by the windings of the excitation coil and the flux-focusing lens (**Fig. 1b**; col. 9 lines 57-58) as it prevents large applied fields from damaging the GMR sensor. This prior art first teaches that a GMR sensor is an improvement, and then further teaches that the use of a feedback coil alleviates problems of the GMR, providing an even further benefit.

One of ordinary skill in the art would have been motivated to modify the probe of Wincheski with the teachings of Tiernan and replaced the pickup coils as the sensors with GMR sensors, as it is a more efficient and accurate sensor. Furthermore, to take full advantage of the improved magnetic sensor, the GMR sensors, one of ordinary skill in the art would have incorporated feedback coils to protect the GMR sensors from any

large applied fields. The argument for the replacement of one pickup coil for one GMR sensor and feedback coil pair can be extended to a plurality of magnetic sensors or pickup coils.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the embodiment with a plurality of magnetic sensors of Wincheski with the teachings of Tiernan such that the pickup coils of Wincheski are replaced with GMR sensors to enhance efficiency and performance, and further enhanced in combination with the addition of feedback coils and second open end of a flux focusing lens, as it would greatly improve the ability to perform nondestructive evaluation on electrically conductive materials.

51. Regarding claim 24, Wincheski does not disclose processing means. However one of ordinary skill in the art would recognize that processing means are well known and useful as they allow for further processing of the signals to obtain the necessary information concerning location and size of defects when doing NDE.

Tiernan discloses a method and device for performing nondestructive evaluation of conductive materials comprising a giant magnetoresistive sensor wherein the device further comprises processing means for processing the signal (col. 5 lines 54-59col. 11 lines 23-25; col. 13 lines 60-62).

One of ordinary skill in the art would have been motivated to modify the combination to further include a processor, as it would allow the user to process the raw signals taken from the GMR sensor and discern useful, viable NDE information from them.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the combination of Wincheski with the teachings of Tiernan to include a processor to make the combination a more useful, and accurate NDE device.

52. Referring to claim 27, Wincheski discloses the eddy current device further comprising an amplifying means (**Fig. 8A** 72) for amplifying the output of the sensor; and a detection means (14) for registering the output of the amplifying means, monitoring means (**Fig. 9** 82) for monitoring the output of the sensor; and scanning means (85-86; col. 8 lines 1-15) for scanning the device about the circumference of the circular inhomogeneity.

53. Regarding claim 29, although neither Wincheski or the teachings of Tiernan specifically disclose the use of a peak to peak detector, the use of such an instrument or even a peak detector, is not novel, and is well known in the art of NDE. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the proposed combination such that the detection means is a peak to peak to detector as it is a well known means for detecting the peaks of the acquired signal.

54. Referring to claim 30, Wincheski discloses a device wherein the monitoring means is a computer (col. 8 line 9).

55. Regarding claim 31, Wincheski discloses a device wherein the scanning means is a stepper motor (col. 8 lines 11-12).

56. Referring to claim 33, Wincheski discloses means for applying a drive current to the windings of the excitation coil (**Fig. 1** 15), wherein the frequency is dependent on the desired depth of flaw detection (col. 6 lines 40-46). The '99 review discloses means for applying a feedback current to the windings of the feedback coil, the feedback current having the same frequency as the drive current but 180 degrees out of phase with the giant magnetoresistive signal (paragraph 11).

57. In reference of claim 36, which describes a method for processing the data in an array, the combination does not disclose the use of an array for data processing. However, in this day and age of computers, the use of arrays for manipulating data is well known, and has been established in the art of NDE. Furthermore, one specific array manipulation is not any different or improved upon another one, and they often are tailored in order to meet the needs of the particular function that they are designed for.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the combination of Wincheski and Tiernan to incorporate a data array manipulation in order to obtain the desired NDE information, as the computer of Wincheski could easily be adapted to perform and process a variety of array manipulations, and any particular manipulation to obtain the desired NDE information could be obtained without undue experimentation.

58. Claims 14 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wincheski-Tiernan as applied to claims 1 and 33 above, and further in view of Dogaru.

Referring to claim 14, Tiernan, which describes the GMR sensor to be used in the combination with Wincheski, does not disclose that the sensor is in its die form.

However, the die form is a well-known form of giant magnetoresistive sensors, and it is often through further modification that a GMR sensor in its die form becomes a GMR sensor in an integrated circuit. Furthermore, Dogaru discloses a method and apparatus for detecting defects in materials comprising a giant magnetoresistive sensor, wherein it is further taught that the giant magnetoresistive sensor can be in die form (col. 8 lines 1-9).

One of ordinary skill in the art would have been motivated to use Dogaru to modify the proposed combination of Wincheski with Tiernan, as it is analogous art, being concerned with NDE using a GMR sensor. Furthermore one of ordinary skill in the art would have modified the combination to use a GMR sensor in die form, as it is a simpler construction of the sensor.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the combination of Wincheski and the teachings of Tiernan with the further teachings of Dogaru such that the GMR sensor was in die form as it is a simpler construction, and may decrease production costs.

59. Referring to claim 34, although the proposed combination does not explicitly disclose the use of a computer to control the amplitude, frequency and phase angle of the source signals, Wincheski alludes to the use of a computer.

Dogaru further discloses the use of a computer to control the scanning of a specimen (col. 8 lines 60-67; col. 9 lines 1-31). The computer is a useful tool as it allows specific software to be written for performing the desired scan.

One of ordinary skill in the art would have been motivated to modify the combination by initiating computer control of the test parameters, as it would allow a higher degree of accuracy, as well as automation.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the proposed combination with the teachings of Tiernan such that the computer of Wincheski is further adapted to be used for controlling the various parameters of the test as it would allow for a higher degree of accuracy and allow automation of the test, resulting in more accurate and more expedient NDE.

Response to Arguments

60. Applicant's arguments filed 12 August 2003 have been fully considered but they are not persuasive. The arguments of record allege that the reference relied on in paper no. 5, and in sections 1-32 of the present office action, is not a proper reference under 102(a). The reference in question is a paper attributed to a presentation given by two of the inventors of the present invention at a conference that took place July 25-30, 1999. The Wincheski et al. "Deep Flaw Detection With Giant Magnetoresistive (GMR) Based Self-Nulling Probe," *26th Annual Review of Progress in QNDE*, Montreal, Canada, July 1999 ('99 Review) reference was understood by the examiner to have had a publication date concurrent with the conference and was relied upon as a statutory bar. The

affidavit filed 12 August 2003 concerning the testimony of Ms. Buchanan has been considered and is now relied upon. Thus, the earliest publication date of the '99 Review is December 3, 1999, which is less than one year before the priority date, and no longer a statutory reference. A printed publication cannot be stand as a reference under 102(a) unless it is the describing the work of another. *In re Katz*, 687 F.2d 450, 454 (CCPA 1982). Therefore, since the authors of the reference relied upon are the inventors named herein, the '99 Review cannot stand as a reference under 102(a).

However, a paper which was orally presented in a forum open to all interested persons constitutes a "printed publication" if written copies are disseminated without restriction. *Massachusetts Institute of Technology v. AB Fortia*, 774 F.2d 1104, 1109, 227 USPQ 428, 432 (Fed. Cir 1985). If written copies were disseminated without restriction at the conference, then the reference would remain a statutory reference. Papers are typically distributed at such conferences and lectures, and often attendees take notes. Thus the question remains as to whether or not written materials were freely available.

The affidavit attributed to Robin W. Edwards contains statements which indicate that there may not have been written materials available at the conference. The statement merely alleges that the inventors, in a phone conversation, stated that there were no materials available, and that the disclosure was nonenabling. As evidence, the statement is given little weight, as it could be construed as hearsay. Therefore the reference has been treated as a statutory reference for the purposes of the present rejection.

Affidavits from Mr. Namkung and Mr. Wincheski declaring that there were no materials freely disseminated would provide greater evidentiary weight in this case, and if provided would be sufficient to overcome the rejection attributed to the '99 Review.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Darrell Kinder whose telephone number is (703) 305-3303. The examiner can normally be reached on Monday-Friday 6:30-4:00, alternate Fridays off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, N. Le can be reached on (703) 308-0750. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

NLe

N. Le
Supervisory Patent Examiner
Technology Center 2800

dk DK